



Fuel Cells: Installation & Operation

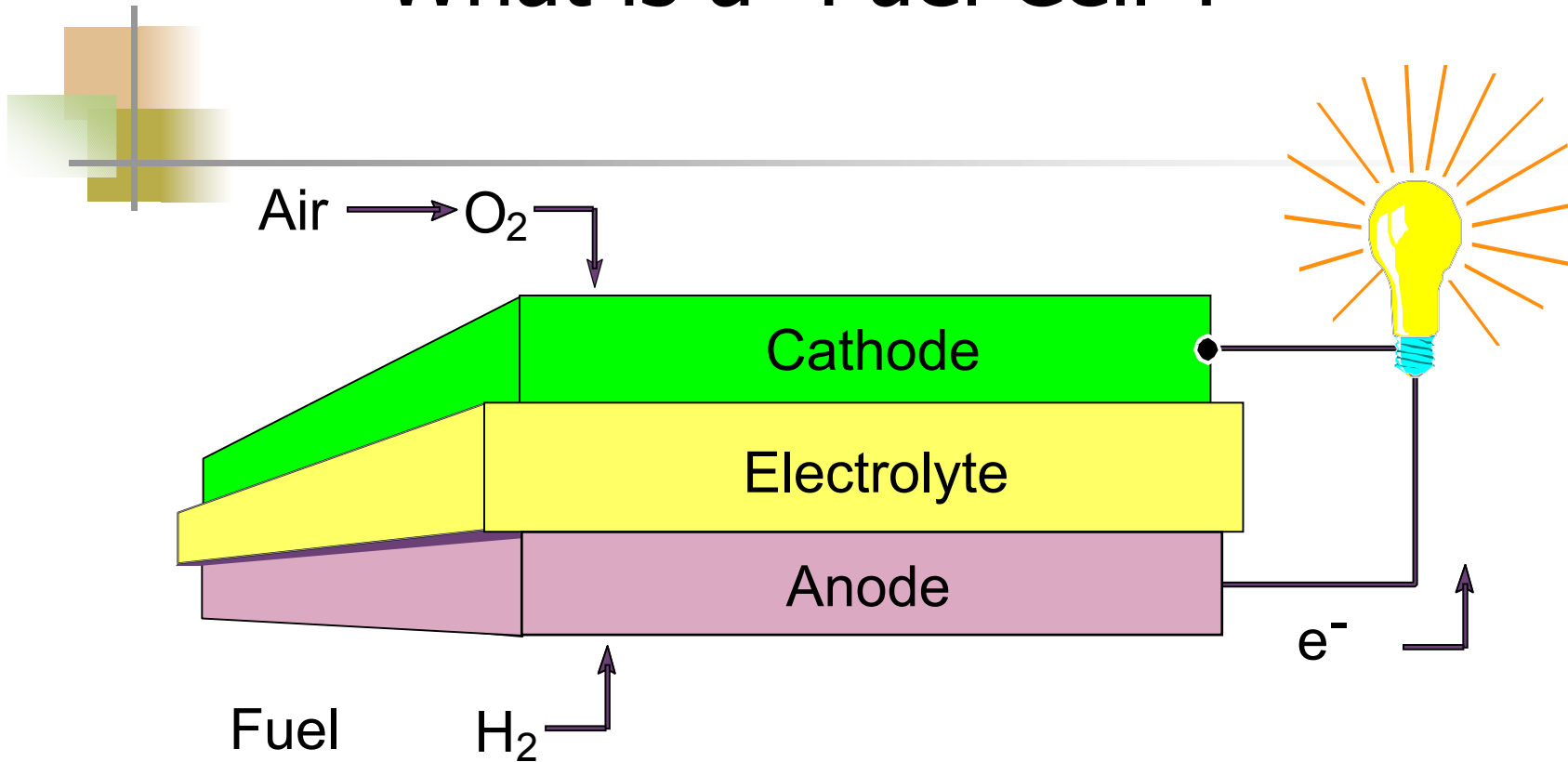
U.S Department of Energy



Overview

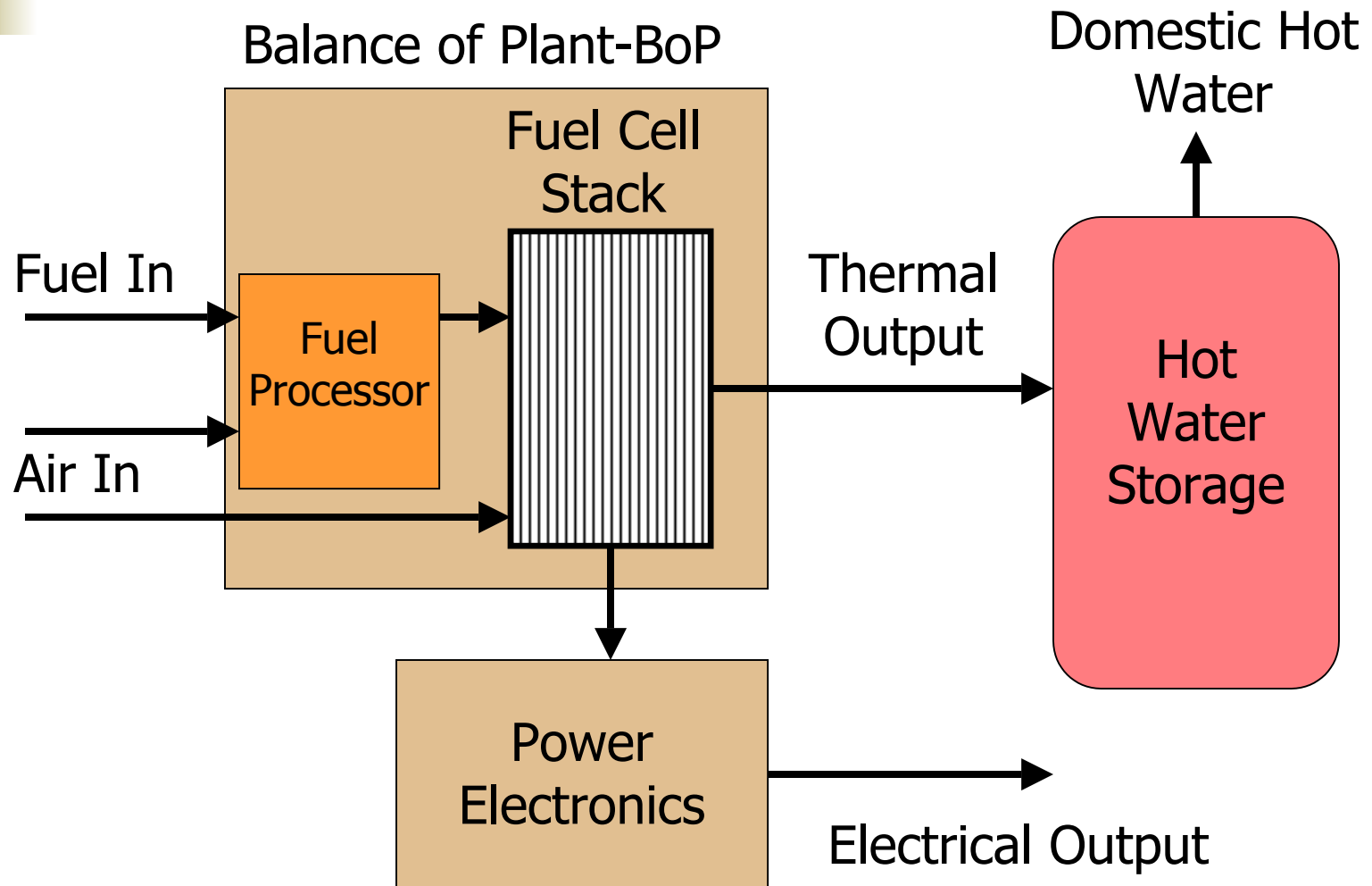
- What is a Fuel Cell?
 - Polymer Exchange Membrane (PEM) Fuel Cells
- What is a Fuel Cell System?
 - Fuel Processor
 - Balance of Plant (BoP)
- Portable and Stationary Fuel Cell Systems
- Codes and Standards
 - Product Standards
 - Installation Standards
 - Interconnect Standards
 - Interim Solution
- System Interfaces/Codes to Bldg Services
- Conclusions

What is a "Fuel Cell"?



- Electrochemical Process
- Direct Conversion to Electricity
- $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{Electricity} + \text{heat}$
- Continuous as long as Air (O₂) & H₂ are provided

What is a Fuel Cell System?





Product Standards

- **ANSI Z21.83** - Standard on Fuel Cell Power Plants. Scope includes stationary FCS. Currently addresses natural gas and propane fueled systems.
- **ANSI CSA FC 1** - This proposed standard will replace Z21.83 and be broadened to include most types of fuels, gas and liquid, hydrocarbons and alcohols.
- **ANSI CSA FC 3** - Draft Portable Fuel Cell Power Generators. Scope includes portable FCS.

Used to Certify Equipment – Not installations

FUEL CELL TECHNOLOGIES

Fuel Cell Technology	Electrolyte	Operating Temperature	Efficiency (%)	
			Electrical	Overall
PEMFC	Ion exchange membrane	50 C	30-35	50-60
AFC	KOH	80 C	Low	Low
PAFC	Phosphoric Acid	200 C	36	80
MCFC	Alkali carbonates	650 C	45-55	75-80
SOFC - High Temp.	Solid metal oxide	980 C	45-47	75-80
SOFC - Reduced Temp.	Solid metal oxide	660 C	42-45	60-70

Source: SFCCG, Inc. (Aug. 1997)



Installation Standards

- **NFPA 70** - National Electrical Code, Article 692
- **NFPA 54** – National Fuel Gas Code
- **NFPA 31** – Installation of Oil-Burning Equipment
- **NFPA 853** – Installation of Stationary Fuel Cell Power Plants. The scope of this standard is for FCS exceeding 50 kW. Work is in progress to revise this standard to include all Stationary Systems (removes the 50 kW clause). Available for public comment through October 4, 2002.



Electrical Interconnection

- **UL 1741** – Standard for Inverters, Converters, and Controllers for use in Independent Power Systems. Scope includes both Grid-Tied and Grid Independent systems.
- **IEEE P 1547** – Standard for Interconnecting Distributed Resources with Electric Power Systems.
- In the future these two standards will be harmonized, and the work done in P1547 will be adopted into UL 1741.

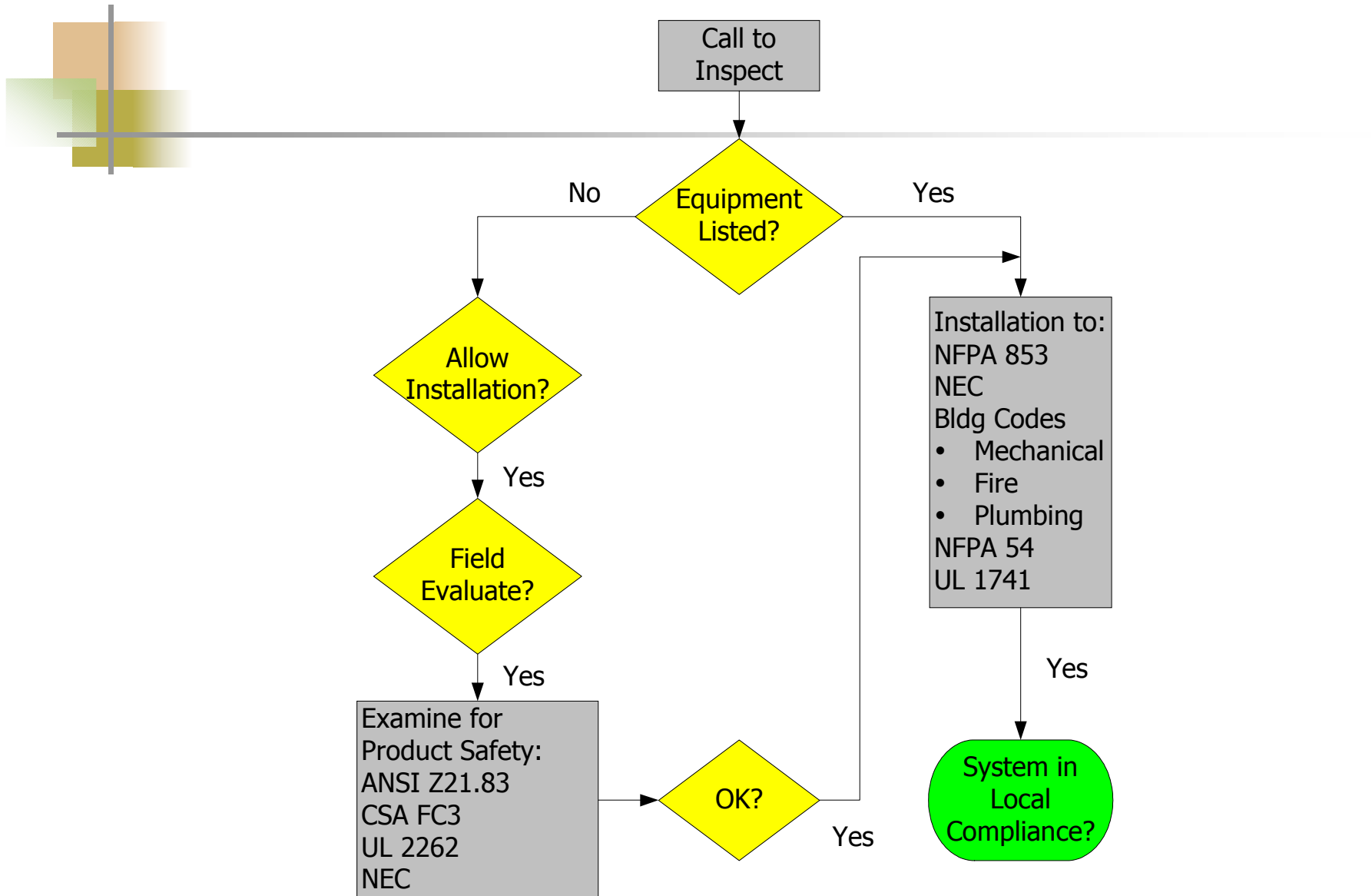


If you **don't** see one of the following symbols, or similar:



1. Don't allow the installation
2. Satisfy your public safety responsibilities with a field evaluation

Field Evaluation Pathway





Standards Applicable for Field Evaluation

- **UL 2262** – Outline of Investigation on PEM type Fuel Cell Power Plants. This is an internal (UL) document developed to help the NRTL assess PEM fuel cells. It is not a national standard and will go away once the proper national standards are developed that cover this topic.
- **ANSI Z21.83**
- **NFPA 70**



NFPA 70: National Electrical Code (2002)

- Grounding-Article 250
- Guarding of live parts-Article 110-27
- Overcurrent protection-Article 240
- Wiring ampacity-Article 310
- Wiring methods-Article 300



Field Evaluations, Cont.

Additional Considerations

- “Approved” components
- Heat rise testing
- Insulation resistance
- Dielectric withstand and leakage current tests
- Ground continuity tests

If there is insufficient guidance in Product Standards, National Standards such as NFPA 79, *Electrical Standard for Industrial Machinery* may be utilized.

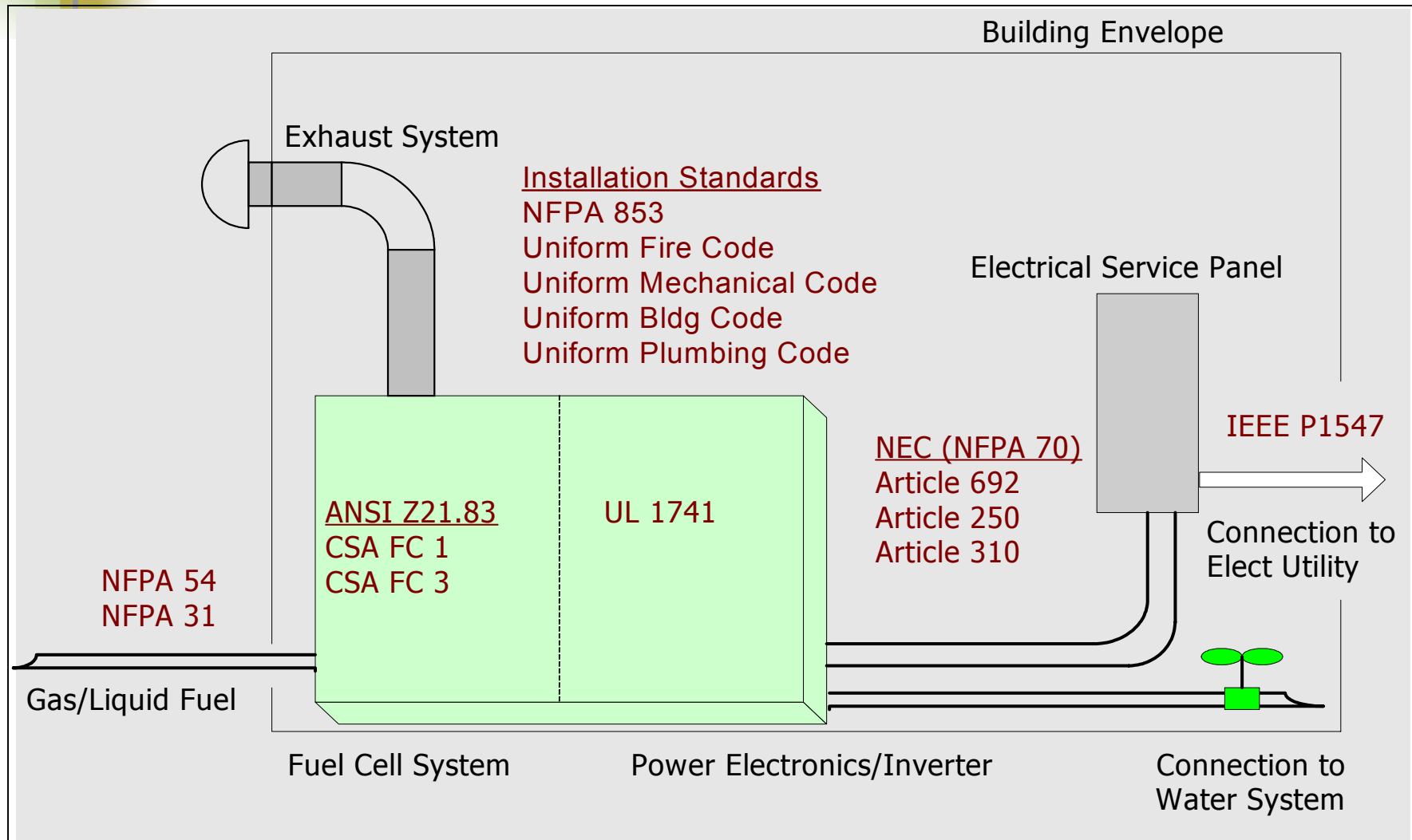


Fire Safety (fire marshal)

- Fuel Tank Location
 - W/respect to occupied spaces
 - W/respect to windows and entry points
- Spills and secondary containment
- Fuel Shutoff - Interlocks

Interfaces

Stationary Fuel Cell System





For more information

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